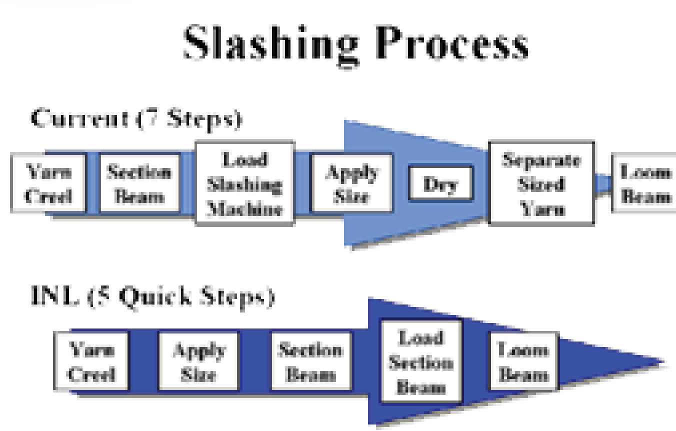
Supercritical Fluid Slashing System

A researcher is coating threads with INL's Supercritical Fluid Slashing System.

Textile mills have relied on current technology for over 100 years, but supercritical sizing may tempt the industry to try a better -- cheaper, faster, smaller and cleaner -- method. The size is transported in a very high-pressure "supercritical fluid" that has both liquid and gas properties. The mixture is forced into threads as they pass through pressure gradient tubes. As the pressure drops, the supercritical fluid turns back into gas, and the sizing is left behind. The technology was developed under a joint DOE-industry initiative to reduce energy use in the textile industry.

Before threads can be woven into fabric, they must be "sized," a process that adds a strengthening and smoothing coating to the thread. Engineer Mark Argyle and chemist Alan Propp of the Idaho National Laboratory have devised a cheaper, faster, smaller, and more environmentally correct method for coating threads with size, one that replaces centuries-old technology. The method transfers size into the threads via a high pressure "supercritical fluid" that has properties of both a fluid and a gas.

Sizing is necessary because the threads in that shirt you're wearing suffer extreme abuse. They are spun, wound on spools, unwound onto beams, dipped in a hot bath of chemicals, dried, "busted" on a bust rod, threaded through a comb, and then woven into the fabric that is cut into the shirt



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you button on in the morning. Sizing -- the dipping-in-a-hot-chemical-bath stage of the traditional textile process -- allows threads to withstand all the friction and stretching and straining of weaving. The size that soaks into the threads during this process is a solution of starch or PVA (polyvinyl alcohol) --compounds that coat the threads for lubrication, smooth down any stray fibers, and strengthen the threads.

Current sizing technologies are the bottleneck in the typical fabric manufacturer's assembly line. The technology, which has remained essentially unchanged since the 1800s, requires a large sizing vat and steam-heated cans the threads roll over to dry. Once dried, the threads must be separated, because the dried size makes them stick together -- they are "busted" to separate the threads. The threads are then spread evenly with a comb and wound onto a loom beam. The sizing vat, drying cans, busting rods and beams in a typical textile plant take up as much space as a basketball court. The sizing and drying take time, too. Currently, textile plants process about 100 yards per minute.

Argyle, perhaps predestined by name to work on textile-related research, and Propp have developed a method that would speed up thread processing by a factor of ten, with a feet-to-inches long machine that would render the basketball court-sized technology obsolete.

A pressure gradient in the device maintains the supercritical conditions. The thread passes through chambers of increasing pressure, until reaching the central, highest pressure section. Here, the size mixture contained in the supercritical environment is forced into the thread. The thread winds out the other end of the tube, passing through regions of lower pressure, where it emerges, dry and sized, at about the same rate --100 yards per minute -- as current methods.

The old-fashioned sizing technology treats many threads at once. The threads may stick together, and separating them weakens the size coating.

Environmentally, the new technique would reduce chemical and water waste in the textile industry. From 40% to 50% of the waste water in a typical textile mill is related to the sizing process. Size vats must be thoroughly rinsed frequently -- dumping nutrients that deplete waterborne oxygen when they are broken down and contributing to algal blooms. The supercritical sizing method would require less size in the machine and less water for clean up. Since it applies size more accurately, less size is needed for each thread.

The prototype supercritical slashing device is about three feet long, but Argyle and Propp hope to shrink it to between eight and 12 inches. They also expect to improve its rate of processing at least two-fold, and perhaps up to 1000 yards per minute. The device could be put into a standard textile mill's assembly line at several different places in the process.

Partnering with INL

The INL's goal is to find a party interested in commercializing this technology. The INL has several patents on the process. See U.S. Patent Nos. 6,495,204, 6,652,654, and 6,623,686. The INL invites interested parties to contact us regarding licensing details.

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